Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently amended) A method of producing a bimetallic catalyst, comprising contacting:
   (a) a modified Ziegler-Natta catalyst made by contacting:
      (i) a Ziegler-Natta catalyst comprising a Group 4, 5 or 6 transition metal; with
      (ii) a modifier comprising a Group 13 metal; the molar ratio of the Group 13 metal to the transition metal ~~being less than~~ having an upper limit of 10:1 and a lower limit of 0.01:1; and
   (b) a metallocene catalyst compound to form a bimetallic catalyst.

2. (Original) The method of Claim 1, the molar ratio of the Group 13 metal to the transition metal is from 0.5:1 to 5:1.

3. (Original) The method of Claim 1, wherein the modifier is a compound or mixture of compounds described by the formula AlX_nR_{3-n}, wherein Al is aluminum, X is independently selected from the group consisting of halides, C_1 to C_{20} alkoxides, C_1 to C_{20} alkylamides, and combinations thereof; and R is independently selected from the group consisting of C_1 to C_{20} alkyls and C_6 to C_{20} aryls; and wherein n is 0, 1, 2 or 3.

4. (Original) The method of Claim 3, wherein n is 1 or 2.

5. (Original) The method of claim 1, wherein the Ziegler-Natta catalyst is not activated.

6. (Original) The method of claim 5, wherein the modified Ziegler-Natta catalyst is not activated.

7. (Original) The method of claim 1, wherein the Group 13 metal is boron or aluminum.

8. (Original) The method of claim 1, wherein the Group 13 metal is aluminum.

9. (Original) The method of claim 1, wherein the bimetallic catalyst additionally includes a first activator in an amount sufficient to activate the modified Ziegler-Natta catalyst.

10. (Original) The method of claim 9, wherein the first activator is an aluminum alkyl in combination with water.

11. (Original) The method of claim 10, wherein the molar ratio of water to aluminum alkyl ranges from 0.01 to 5.

12. (Original) The method of Claim 10, wherein the water and aluminum alkyl are added simultaneously with the bimetallic catalyst in a polymerization reactor.

13. (Original) The method of claim 1, wherein the bimetallic catalyst additionally includes a first activator for activating the modified Ziegler-Natta catalyst, wherein the first activator contains aluminum, and wherein the molar ratio of the first activator aluminum to the Ziegler Natta transition metal is greater than 10:1.

14. (Original) The method of claim 13, wherein the molar ratio of the first activator aluminum to the Ziegler Natta transition metal is greater than 20:1.

15. (Original) The method of claim 1, wherein the bimetallic catalyst additionally includes a second activator in an amount sufficient to activate the metallocene catalyst compound.

16. (Original) The method of claim 15, wherein the second activator is methyl aluminoxane (MAO) in an amount sufficient to activate the metallocene catalyst compound.

17. (Original) The method of claim 1, wherein the molar ratio of the Group 13 metal of the modifier to the transition metal is from 0.5:1 to 7:1.

18. (Original) The method of claim 1, wherein the molar ratio of the Group 13 metal of the modifier to the transition metal is from 0.5:1 to 5:1.

19. (Original) The method of claim 1, wherein the molar ratio of the Group 13 metal of the modifier to the transition metal is from 0.5:1 to 3:1.

20. (Original) The method of claim 1, wherein the Ziegler-Natta catalyst is formed by contacting an organomagesium compound comprising at least one alkyl group with a Group 4 or 5 transition metal halide or oxide compound.

21. (Original) The method of claim 1, wherein the Ziegler-Natta catalyst is formed by contacting an organomagesium compound with titanium chloride compound, wherein the organomagnesium compound has the formula $Mg(OR)_2$ or $R^1{}_mMgR^2{}_n$; where R, R^1, and R^2 are C_1 to C_8 alkyl groups, and m and n are 0, 1 or 2.

22. (Original) The method of claim 1, wherein the modified Ziegler-Natta catalyst is supported on a support material.

23. (Original) The method of claim 1, wherein the metallocene catalyst compound is activated prior to contacting.

24. (Original) The method of claim 1, wherein the Ziegler-Natta catalyst is first prepared, followed by contacting with the modifier without isolating the Ziegler-Natta catalyst prior to contacting with the modifier.

25. (Original) The method of claim 1, wherein the bimetallic catalyst has a productivity greater than 4,000 g polymer/g catalyst at from 80 to 100°C in a gas phase polymerization reactor.

26. (Original) The method of claim 1, wherein the bimetallic catalyst has a productivity greater than 6,000 g polymer/g catalyst at from 80 to 100°C in a gas phase polymerization reactor.

27-32 (Cancelled)

33. (Currently amended) A bimetallic catalyst, comprising a support material; a metallocene catalyst compound bound to the support material; and a modified Ziegler-Natta catalyst bound to the support material; wherein the modified Ziegler-Natta catalyst is a reaction product of a Ziegler-Natta catalyst comprising a Group 4 or 5 transition metal and a modifier comprising aluminum; and wherein the molar ratio of aluminum to titanium ~~is less than~~ has an upper limit of 10:1 and a lower limit of 0.01:1.

34. (Original) The bimetallic catalyst of claim 33, in which the bimetallic catalyst is non-activated.

35. (Original) The bimetallic catalyst of claim 33, in which the bimetallic catalyst is activated.

36. (Original) The bimetallic catalyst of claim 33, in which the modified Ziegler-Natta catalyst is an non-activated reaction product of a Ziegler-Natta catalyst that includes titanium and is reacted with a modifier that includes aluminum.

37. (Original) The bimetallic catalyst of claim 33, in which the support material is silica.

38. (Original) The bimetallic catalyst of claim 33, in which the metallocene catalyst compound comprises zirconium.

39. (Original) The bimetallic catalyst of claim 33, in which the modifier is diethylaluminum chloride.

40. (Original) The bimetallic catalyst of claim 33, in which the modifier is ethyl aluminum sesquichloride.

41. (Original) The bimetallic catalyst of claim 33, in which the modifier is diethylaluminum ethoxide.

42. (Original) The bimetallic catalyst of claim 33, in which the molar ratio of aluminum to titanium is less than 7:1.

43. (Original) The bimetallic catalyst of claim 33, in which the molar ratio of aluminum to titanium is less than 5:1.

44. (Original) The bimetallic catalyst of claim 33, in which the molar ratio of aluminum to titanium is less than 3:1.

45. (Currently amended) A method of producing a bimodal polyethylene comprising contacting ethylene and C_3 to C_{10} α-olefins with a bimetallic catalyst compound produced by a method comprising contacting:

(a) a modified Ziegler-Natta catalyst made by contacting:

(i) a Ziegler-Natta catalyst comprising a Group 4, 5 or 6 transition metal; with

(ii) a modifier comprising a Group 13 metal; the molar ratio of the Group 13 metal to the transition metal ~~being less than~~ having an upper limit of 10:1 and a lower limit of 0.01:1; and

(b) a metallocene catalyst compound to form a bimetallic catalyst.

46. (Original) The method of Claim 45, the molar ratio of the Group 13 metal to the transition metal is from 0.5:1 to 5:1.

47. (Original) The method of Claim 45, wherein the modifier is a compound or mixture of compounds described by the formula AlX_nR_{3-n}, wherein Al is aluminum, X is a halide, and R is independently selected from the group consisting of C_1 to C_{20} alkyls, C_1 to C_{20} alkoxides, C_1 to C_{20} alkylamides, and combinations thereof; and n is 0 to 3.

48. (Original) The method of Claim 45, wherein the modifier is a compound or mixture of compounds described by the formula AlX_nR_{3-n}, wherein Al is aluminum, X is independently selected from the group consisting of halides, preferably fluoride, chloride or bromide, C_1 to C_{20} alkoxides, C_1 to C_{20} alkylamides, and combinations thereof; and R is independently selected from the group consisting of C_1 to C_{20} alkyls and C_6 to C_{20} aryls; and wherein n is 1, 2 or 3.

49. (Original) The method of claim 45, wherein the Ziegler-Natta catalyst is not activated.

50. (Original) The method of claim 49, wherein the modified Ziegler-Natta catalyst is not activated.

51. (Original) The method of claim 45, wherein the Group 13 metal is boron or aluminum.

52. (Original) The method of claim 45, wherein the Group 13 metal is aluminum.

53. (Original) The method of claim 45, wherein the bimetallic catalyst additionally includes a first activator in an amount sufficient to activate the modified Ziegler-Natta catalyst.

54. (Original) The method of claim 53, wherein the first activator is an aluminum alkyl in combination with water.

55. (Original) The method of claim 54, wherein the molar ratio of water to aluminum alkyl ranges from 0.01 to 5.

56. (Original) The method of Claim 54, wherein the water and aluminum alkyl are added simultaneously with the bimetallic catalyst in a polymerization reactor.

57. (Original) The method of claim 45, wherein the bimetallic catalyst additionally includes a first activator for activating the modified Ziegler-Natta catalyst, wherein the first activator contains aluminum, and wherein the molar ratio of the first activator aluminum to the Ziegler Natta transition metal is greater than 10:1.

58. (Original) The method of claim 57, wherein the molar ratio of the first activator aluminum to the Ziegler Natta transition metal is greater than 15:1.

59. (Original) The method of claim 57, wherein the molar ratio of the first activator aluminum to the Ziegler Natta transition metal is greater than 20:1.

60. (Original) The method of claim 45, wherein the bimetallic catalyst additionally includes a second activator in an amount sufficient to activate the metallocene catalyst compound.

61. (Original) The method of claim 60, wherein the second activator is methyl aluminoxane (MAO) in an amount sufficient to activate the metallocene catalyst compound.

62. (Original) The method of claim 45, wherein the molar ratio of the Group 13 metal of the modifier to the transition metal is from 0.5:1 to 7:1.

63. (Original) The method of claim 45, wherein the molar ratio of the Group 13 metal of the modifier to the transition metal is from 0.5:1 to 5:1.

64. (Original) The method of claim 45, wherein the molar ratio of the Group 13 metal of the modifier to the transition metal is from 0.5:1 to 3:1.

65. (Original) The method of claim 45, wherein the Ziegler-Natta catalyst is formed by contacting an organomagesium compound comprising at least one alkyl group with a Group 4 or 5 transition metal halide, alkoxide or oxide compound.

66. (Original) The method of claim 45, wherein the Ziegler-Natta catalyst is formed by contacting an organomagesium compound with titanium tetrachloride, wherein the organomagnesium compound has the formula $Mg(OR)_2$ or $R^1{}_mMgR^2{}_n$; where R, R^1, and R^2 are alkyl groups, and m and n are 0,1 or 2.

67. (Original) The method of claim 45, wherein the modified Ziegler-Natta catalyst is supported on a support material.

68. (Original) The method of claim 45, wherein the metallocene catalyst compound is activated prior to contacting.

69. (Original) The method of claim 45, wherein the components in steps (i) and (ii) of step (a) are combined prior to entering the polymerization reactor.

70. (Original) The method of claim 45, wherein the bimetallic catalyst has a productivity greater than 4,000 g polymer/g catalyst at from 80 to 100°C in a gas phase polymerization reactor.

71. (Original) The method of claim 45, wherein the bimetallic catalyst has a productivity greater than 6,000 g polymer/g catalyst at from 80 to 100°C in a gas phase polymerization reactor.

72. (Original) The method of Claim 45, wherein the component in step (ii) is combined simultaneously with trimethylaluminum in a polymerization reactor; and wherein the component in step (ii) excludes trimethylaluminum.

73. (Currently Amended) A bimodal polyethylene comprising ethylene derived units and any one or more C_3 to C_{10} derived units; wherein the bimodal polyethylene possesses an Mw/Mn value of from ~~12 to 50~~ 10 to 80 and a value of Mz of greater than 1,000,000 made by the method of Claim 45.